

## ***Interactive comment on “Recirculation in the Fram Strait and transports of water in and north of the Fram Strait derived from CTD data” by M. Marnela et al.***

### **Anonymous Referee #2**

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This paper presents geostrophic flow calculations from hydrographic data in the vicinity of Fram Strait, together with volume, temperature and salinity conservation constraints, to calculate volume, freshwater and heat fluxes. Sea-ice melt is shown to account for divergences in freshwater fluxes in a control box in the Strait and to the north. The effect of recirculation of Atlantic Water is also taken into account. The paper is a worthwhile contribution that presents a detailed analysis of hydrographic data that can shed light on our understanding of freshwater and heat fluxes, variability, and causes of the observed variability in the major gateway to the Arctic Ocean. The introduction provides a succinct overview that points to a comprehensive set of references. However, in parts the paper is overly drawn-out, poorly written, and the analysis is inadequately

presented and confusing. Much of the manuscript needs to be greatly improved before it will be publishable. Specific suggestions for improvement are given below.

1. Wherever possible, data that are given in tabular form would be better represented graphically. There are too many long tables that would be better found in a lab book. Graphical form would help a great deal.
2. The data accuracies are well described, however, the authors should comment on what the accuracy limitations mean for the results, particularly for the questionable accuracies. Further in this section, the visual estimation of the ice-edge location is discussed and it is also mentioned that the ERA Interim Reanalyses data are used in conjunction, however it is unclear where in the manuscript these measurements are actually used (nor how they are used together)?
3. The description of the geostrophic calculations (Section 3.1) is hard to follow; a schematic would be very helpful here. It is confusing that across a section a different level of no motion is assumed for each station pair. Shouldn't the depth of the shallowest station in the section be taken as the level of no motion for every pair, rather than the shallowest level in each pair? Section 3.2.1 would also be greatly helped with a diagram showing the boxes and layers with arrows. In Section 3.2.2, I'm having trouble reconciling equation (4) with the constraints/definitions in (3). It seems the first term in parentheses of (4) would be zero in light of the definition of the first constraint, for example. State with the definitions after (4) that  $\lambda$  are the eigenvalues. The earlier references of the technique should be given here (Wunsch's book on inverse methods for one). Throughout the manuscript, the difference between bottom depth (the depth of the ocean) and the deepest measurement in a cast need to be made clear.
4. In Section 3.2.3, the idealized sections and boxes should be drawn schematically. The 1997, 2001 and 2003 CTD stations for the north-south sections need to be shown in this section, rather than later (i.e. Figure 4 should come before Figure 3).
5. Table 1 and related discussion: Mixing signs for southward/northward flow is

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very confusing. It's more conventional to make northward flow positive, regardless of whether it is entering or exiting a box. At the very least, it should be consistent throughout the paper (cf. Table 7, for example).

6. Section 4.1.1: What is the meaning of: "... averaged over the four east-west section pairs." ?

7. Section 4.2.1: The choice of variable reference temperature and salinity is confusing. Of course, it is incorrect to do this when making interannual comparisons, and the difference when examining flow in a control volume needs to be made more explicit.

8. Section 4.2.2: Change "To melt ice equivalent ..." to "The mass of ice equivalent ..." and then, "The heat needed to melt this mass of ice is.. " Line 19: One needs to subtract two numbers in Table 2 is arrive at 37 mSv. This applies to the other numbers given here. At least put these in the table, and refer to the Table so the reader does not have to go hunting.

9. Section 5.2.2: It seems like an arbitrary assumption that the unsampled boundary regions of the sections "cancel out". An estimate of the deformation radius, and the width of the unsampled region should be given here.

10. Table 6: The "no constraints applied" part should go first. Why " $v = 0$  at the bottom"? Is this different from your analysis of the zonal sections?

11. Figure 1: Are the colors meant to have any particular meaning here? The three lines converging at the EGC line should all have arrows.

12. Figure 3: Multi-colored contours would be better for interpretation, rather than shades of green. Does the flow really reach 60 cm/s (i.e. is this scale range necessary)? Panels starting on page 3181: What do the "L" and "R" mean and the schematic in the bottom left corner of the velocity section? Clearly, a schematic is required before we get to this point. This figure has way too many panels that aren't really even discussed in the text. Could one year only be shown to give the reader an

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idea of the basic flow structure only?

13. Figure 5: A better caption and panel titles are needed here. It is unclear what the bottom three panels are referring to. In the caption, rather than "...and the net heat and ..." use (a) and (b) and title all panels.

14. Figure 6: Why is the convergence and divergence shown? I don't see how the "conv/div" dots in the legend are used here.

15. There are several grammatical errors and typos (even an incomplete sentence, and more than one sentence that begins with "Also") and I suggest very careful proof-reading prior to re-submission.

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